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(54) Heat exchangers and heat exchanger headers

(57) Tubed heat exchangers are constructed with moulded plastics headers made up of a number of separately moulded sections (46). The sections provide fluid flow conduits communicating with the tubes (42) of the heat exchanger and can be arranged to have partitioning (56) to give a variety of parallel and/or series connections between the tubes of the heat exchanger. Direct connection between adjoining header sections may be provided by integrally moulded sealing arrangements (54) at the ends of the fluid flow conduits (48). In a further arrangement the header may be in the form of a matrix composed of similar sections bonded together.

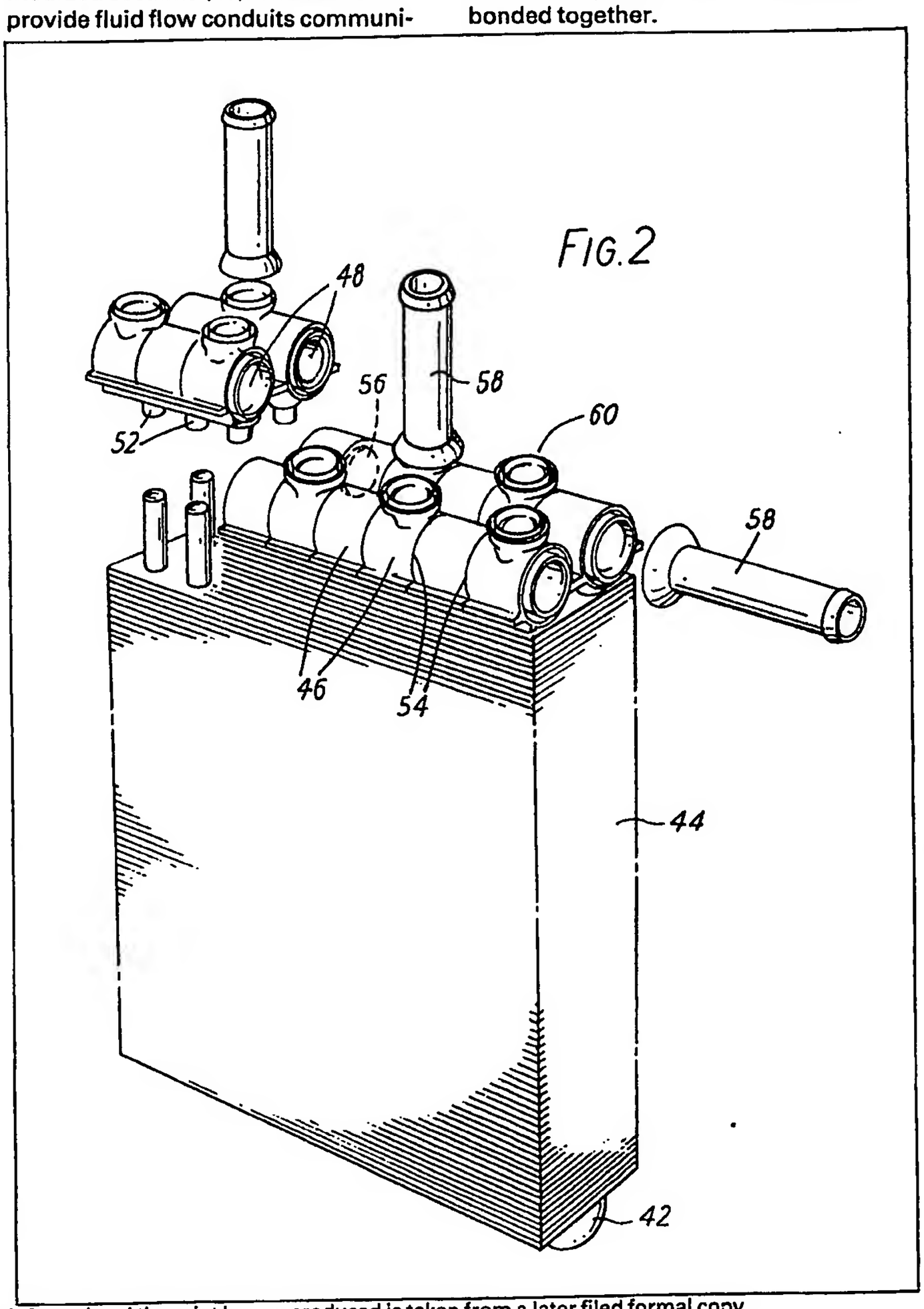

FIG.2

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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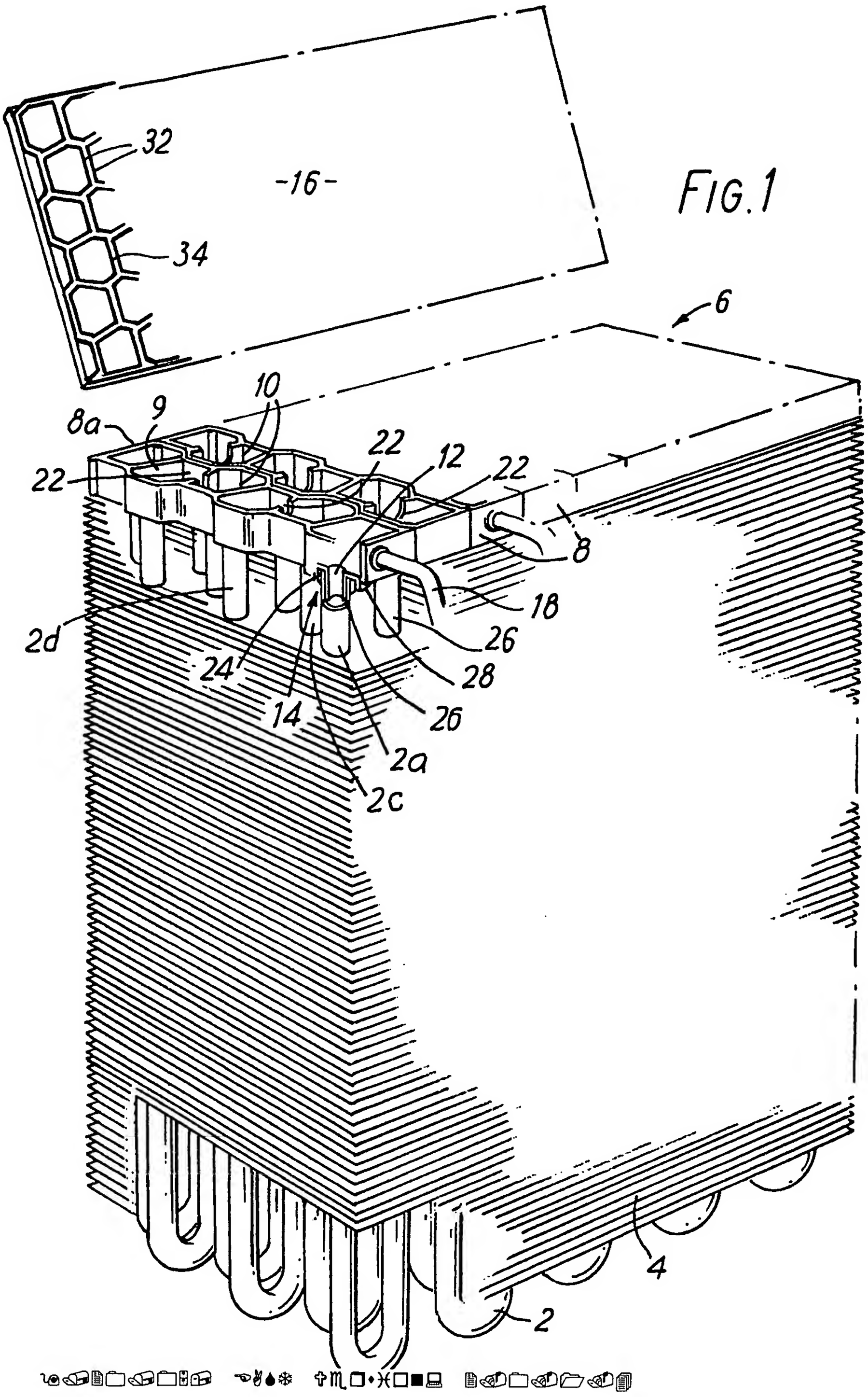

FIG. 1

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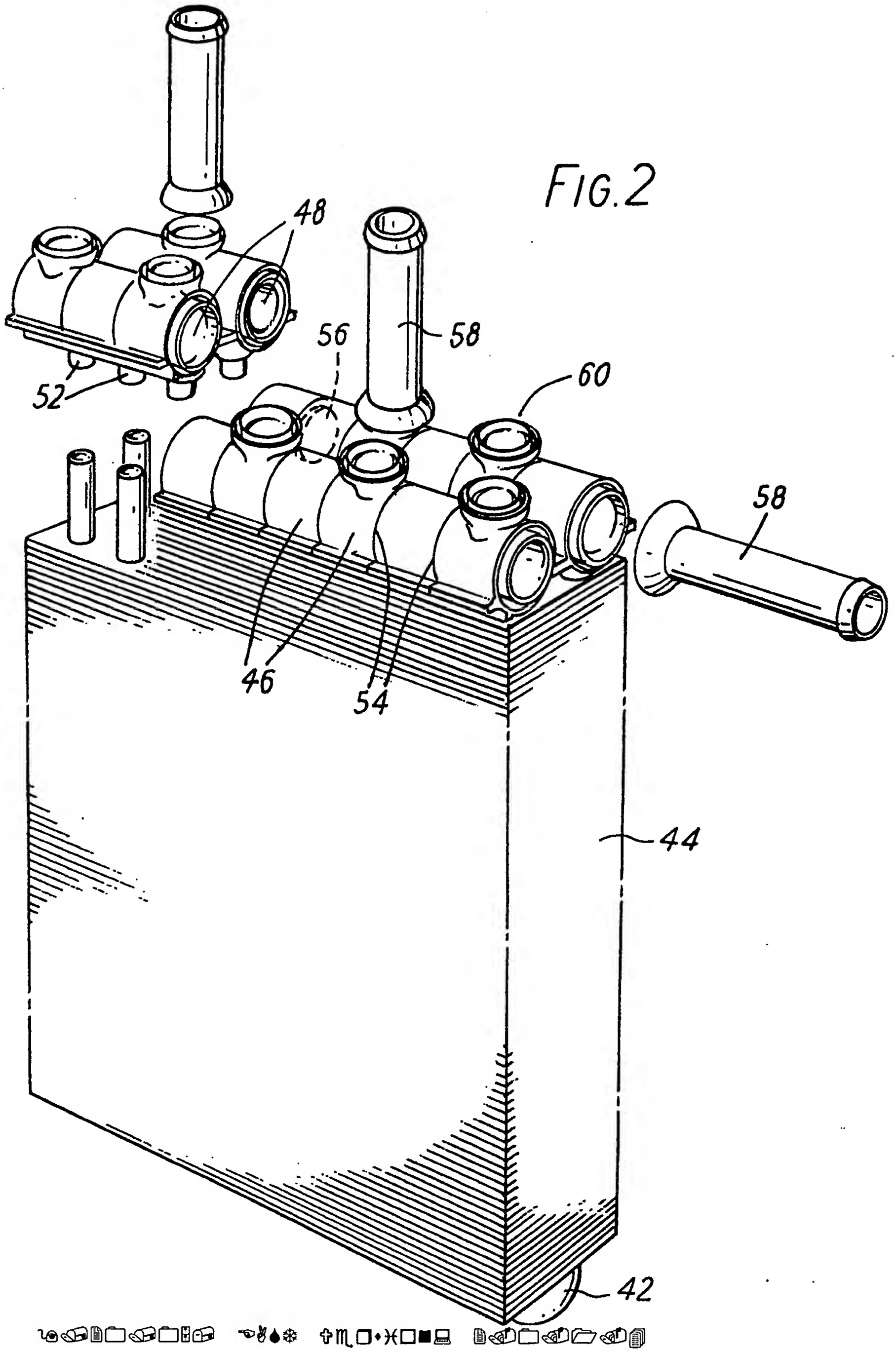

FIG.2

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FIG.3

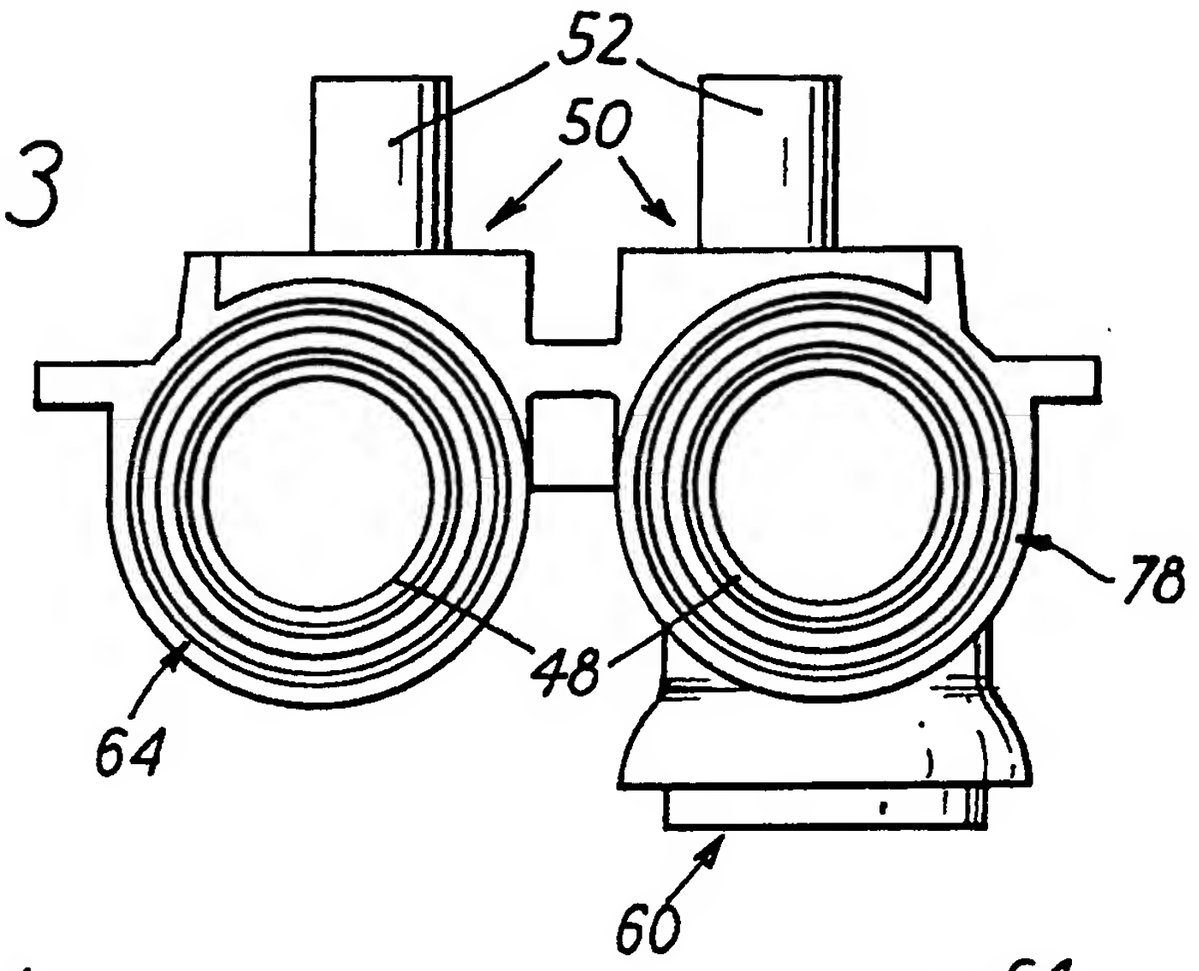

FIG.4

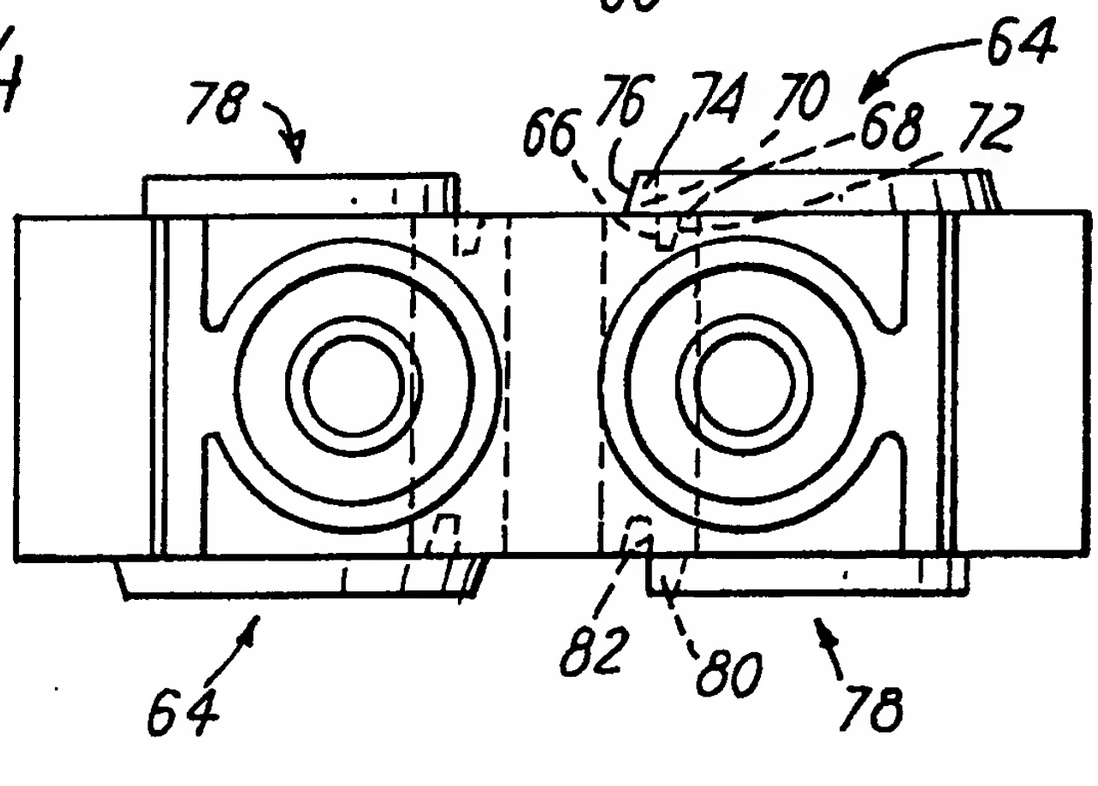

FIG.5

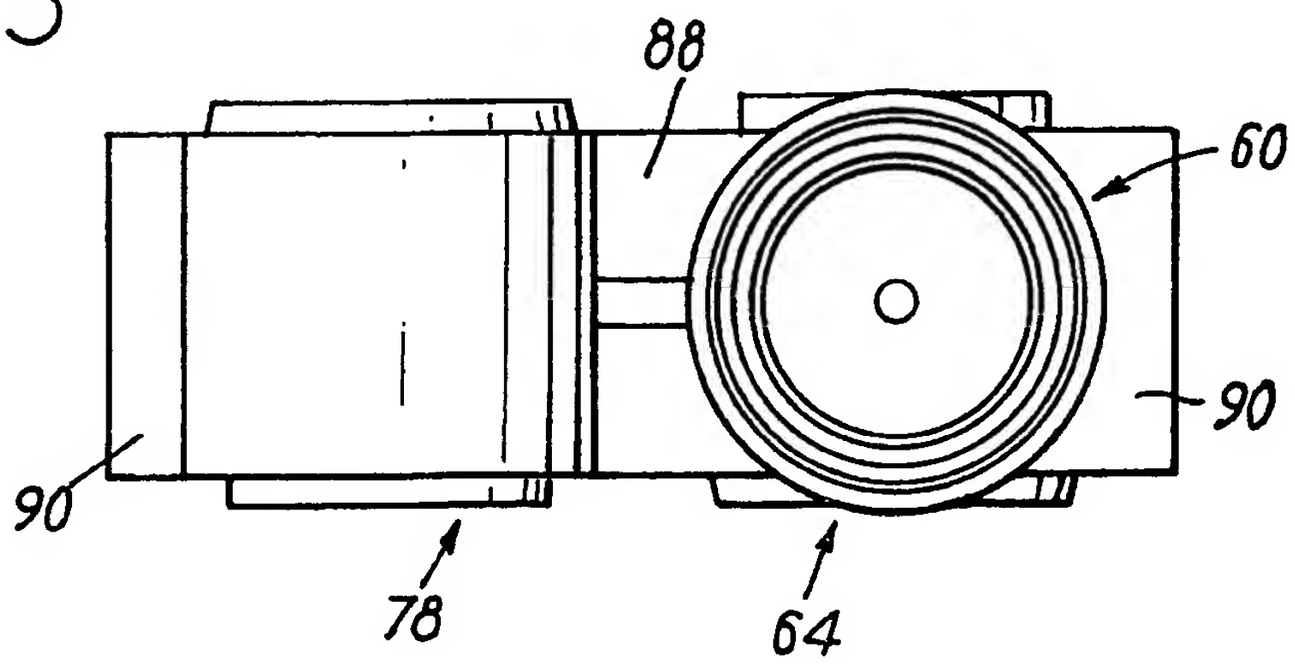

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FIG. 6

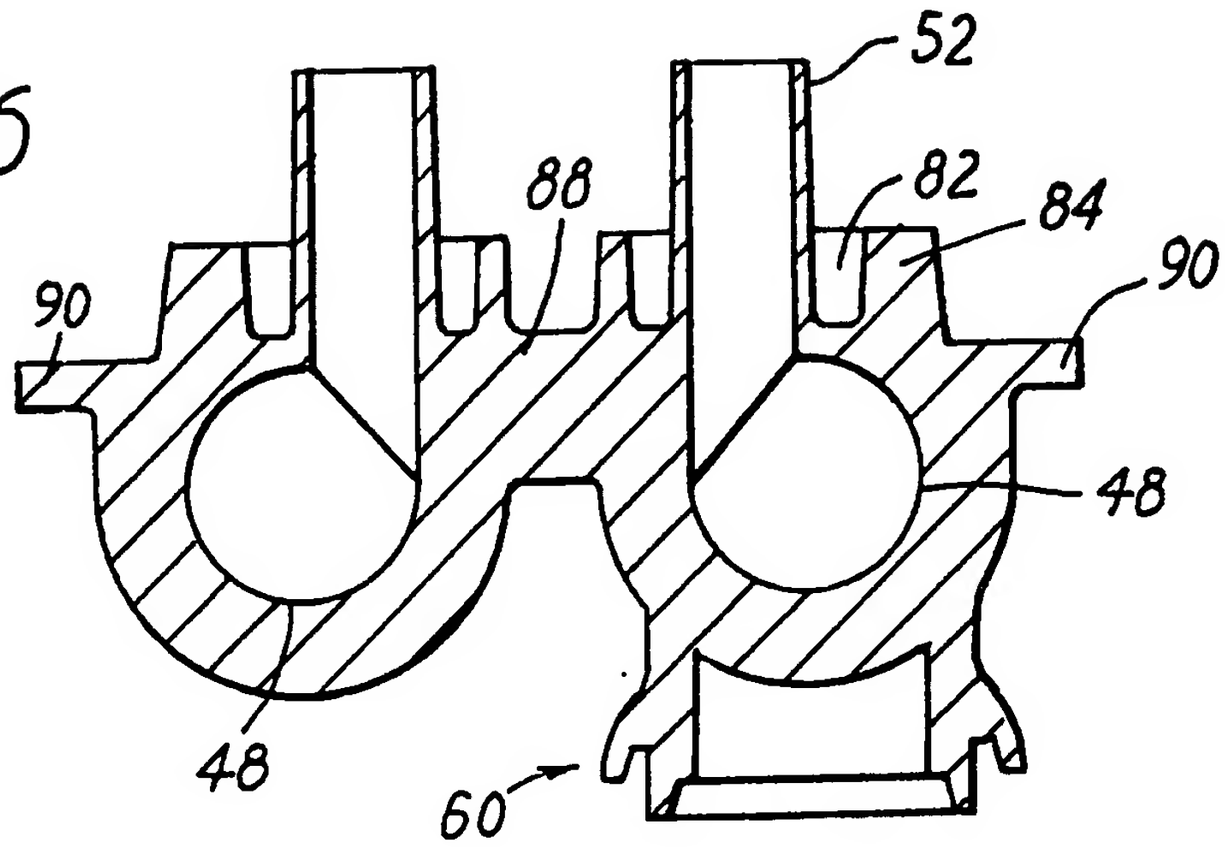


FIG. 7

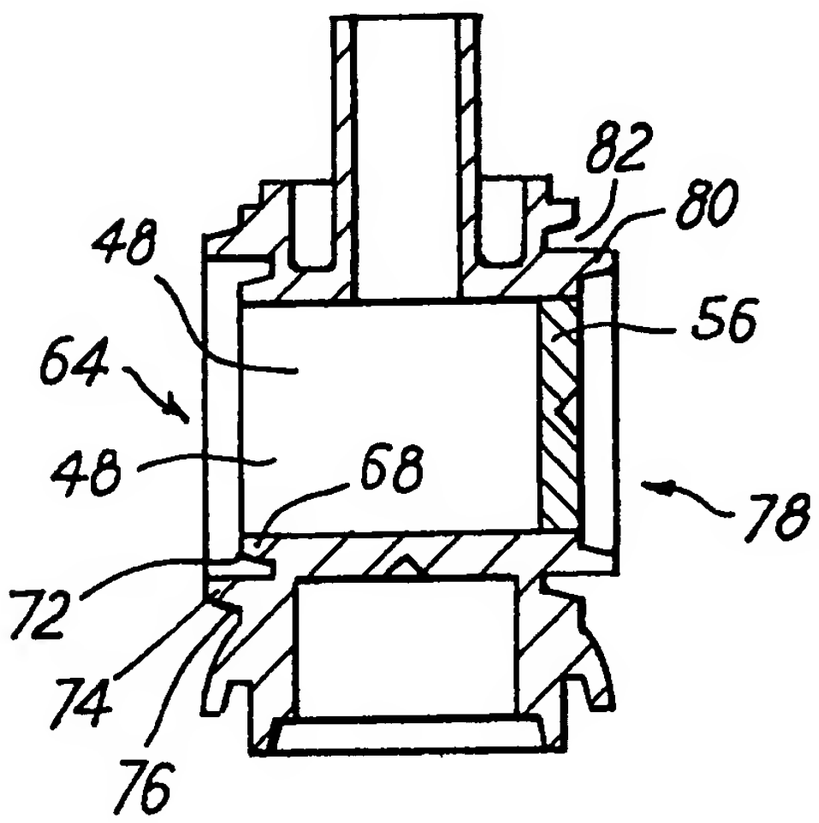
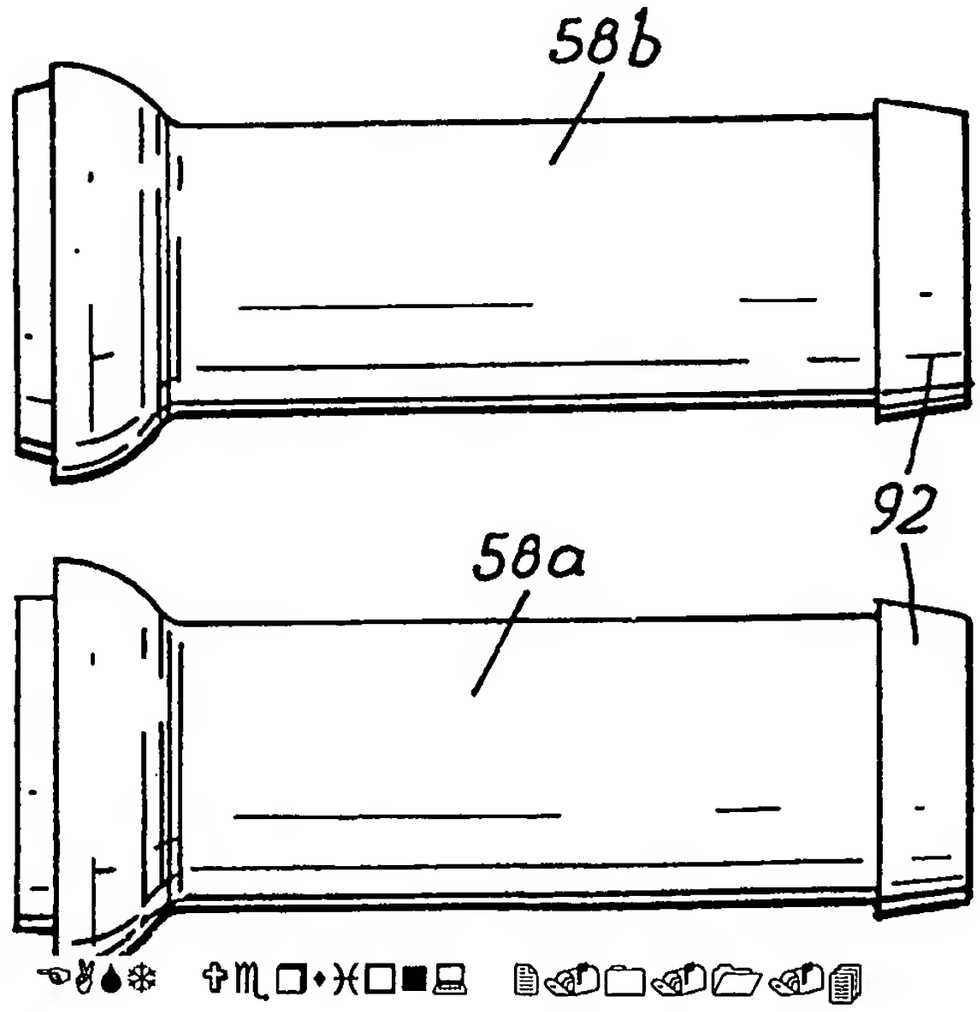


FIG. 8



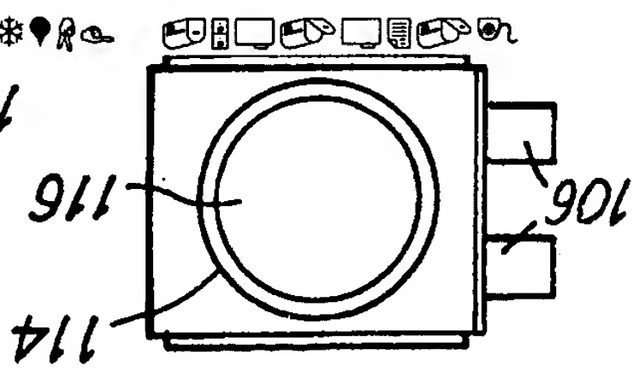


FIG. 13

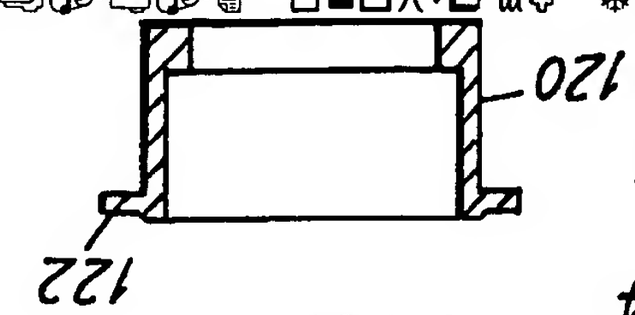


FIG. 14

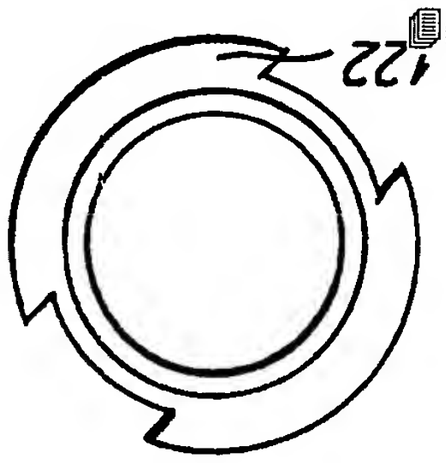


FIG. 15

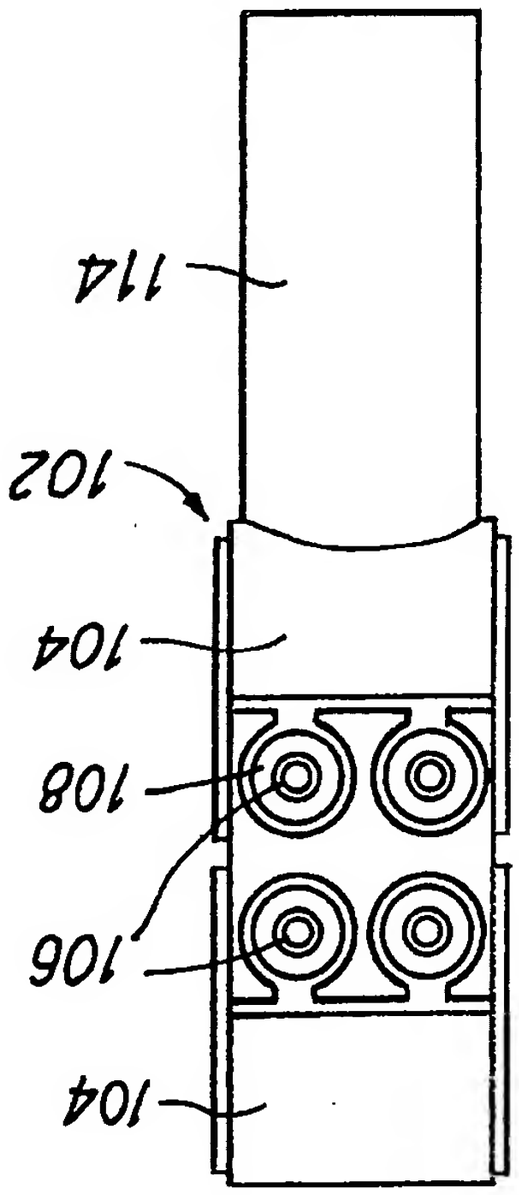


FIG. 11

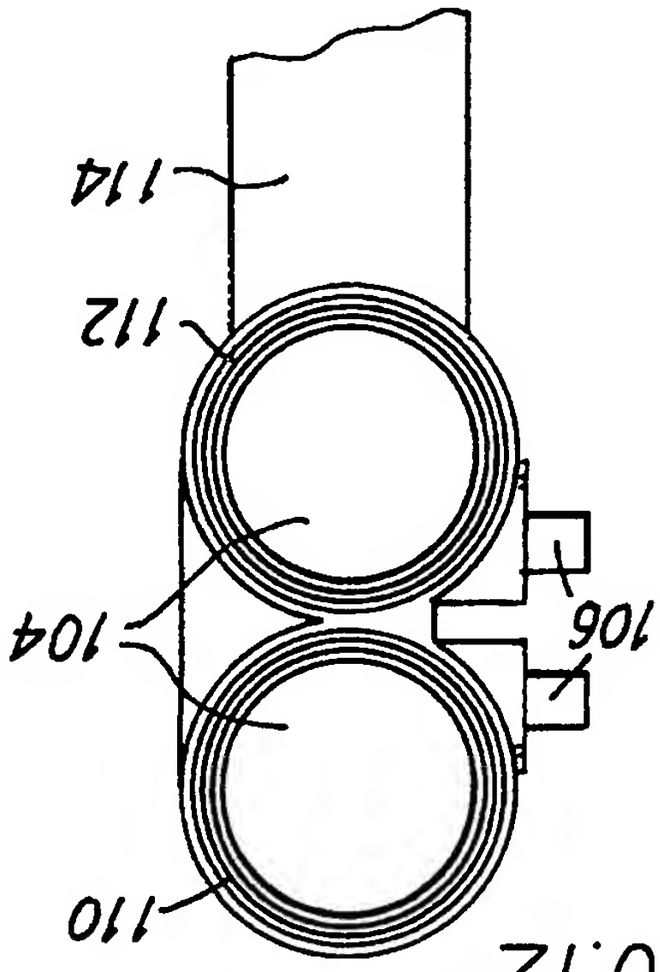


FIG. 12

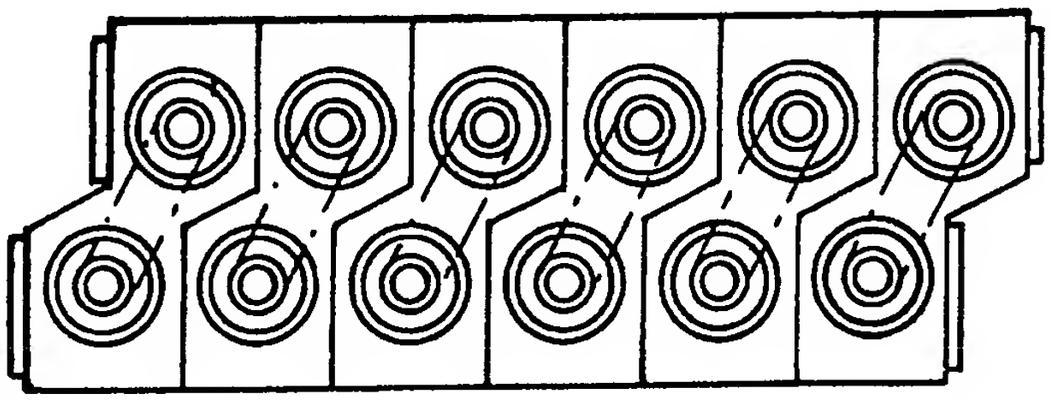


FIG. 10

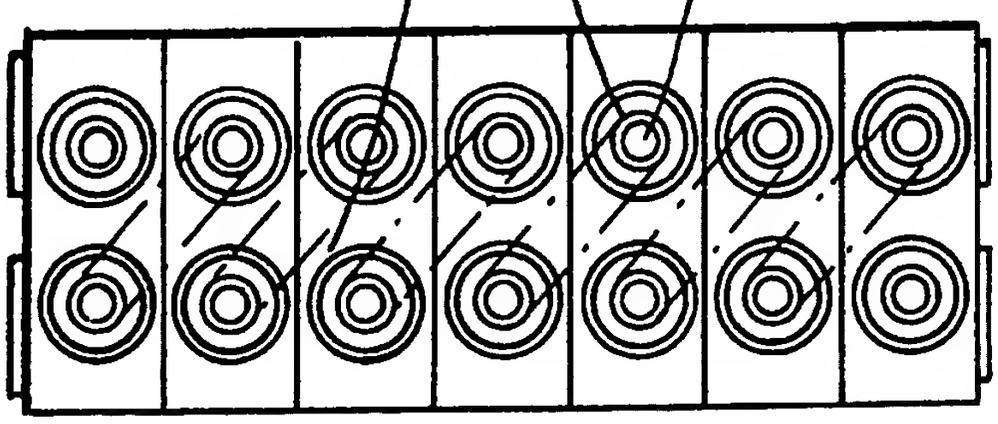


FIG. 9

SPECIFICATION

Heat exchangers and heat exchanger headers

This invention relates to heat exchangers, and in particular to the construction of headers of plastics materials for heat exchangers.

The use of plastics materials for headers has a number of advantages, in that relatively complex forms of moulded header can be produced more economically than is possible with a sheet metal construction and at a smaller material cost, while there is less risk of leakage because soldered joints are avoided. However, very complex tooling is required for moulding a header from a plastics material, while the completed headers are bulky and can represent a considerable stock investment. The potential savings may be lost for these reasons, this being a disadvantage that is particularly accentuated if smaller quantities are to be produced of particular patterns of header.

The present invention aims to provide a form of construction in which different forms of header can be produced using relatively simple tooling, and which can help to limit the need to maintain large stocks of expensive parts.

According to the invention, there is provided a heat exchanger having a plurality of heat exchange tubes and at least one header of plastics material comprising a series of hollow header sections secured together, the header sections having fluid inlet and outlet openings to provide flow conduits for connecting said tubes, in at least some of the header sections at least one of said openings being provided with connection means for sealingly engaging a tube end in communication with the hollow interior of the respective header section.

In one form of the invention, there is provided a heat exchanger having a plurality of heat exchange tubes and at least one header of plastics material comprising a plurality of hollow header sections secured together, each header section having openings with connection means for respective tube ends to spaced regions of the interior of the section and partitioning means being provided between the connection means for at least some of the tube ends to divide the interior of the section into a plurality of separate compartments.

According to another form of the invention, there is provided a heat exchanger having a plurality of heat exchange tubes and at least one header of plastics material comprising a series of hollow header sections secured together, at least some of said header sections providing at least one tubular passage extending between opposite end faces of the section, the or at least one said tubular passage of said header sections having a tube connection opening provided with connection means for a respective end, and an annular sealing arrangement being provided around the respective passage ends in each of the header section end faces for sealing engagement with a further similar hollow header section.

The invention will be described in more detail with reference to

Figure 1 is a perspective view of a first embodiment of the invention with parts removed to illustrate its construction more clearly,

Figure 2 is a perspective view of a partly dismantled second embodiment of the invention,

Figures 3 to *8* illustrate components of the embodiment of Figure 2, Figure 3 being an end view of a header section,

Figures 4 and *5* being views of the header section in the direction of arrows A and B respectively in Figure 3,

Figures 6 and *7* being sections of C-C in Figure 4 and D-D respectively in Figure 3, and

Figure 8 being side views of two pipe sockets for the external connection to the header.

Figures 9 and *10* are schematic underplan views of modified forms of this second embodiment of the invention,

Figures 11 to *13* are mutually transverse views of a header section for a further embodiment of the invention, similar in some respects to the example shown in Figures 2 to 10, and

Figures 14 and *15* are axial section and plan views of a filler neck member that can be employed with the header section of Figures 11 to 13 for example.

Referring to Figure 1 of the drawings, there is illustrated a tubed heat exchanger, more specifically an evaporator of a refrigeration unit, comprising a series of U-tubes 2 with their limbs mounted in parallel formation in a matrix 4 which is shown only schematically and which can be built up in known manner using a series of support elements and sheet metal cooling fins through which the tubes runs. The open ends of the U-tubes project above the matrix to be connected in a fluid-tight manner to a header 6 which comprises a series of individual sections 8 bonded together. Only a couple of sections have been illustrated in detail, but the entire area of the header over the top face of the heat exchange matrix is composed of similar sections bonded together.

Each section 8 is a trough-like member partitioned by interior walls 9 into a series of adjoining compartments 10 each with a bottom opening 12 leading to a spigoted socket 14 that receives tube end, so that the tubes 2 are connected to separate compartments. The successive compartments of a section are arranged in a slightly zig-zag row, because successive rows of tube ends are staggered relative to each other. The sections are bonded to each other, for example by adhesive or by ultrasonic welding, and a moulded plastics cover plate 16 sealingly encloses the tops of the compartments. The cover plate is similarly bonded to the sections 8 and it is shown with a rib-like formation 32 on its underface that provides channels 34 in which the upper edges of the walls of the sections 8 seat. Like the sections 8, the cover plate can be formed from a number of separate smaller mouldings.

Liquid admitted through an external connection 18 to the first compartment of the end section 8*a* of the header flows down the limb 2*a* of the U-tube opening into said compartment and returns through the other limb 2*b* of the tube to the adjacent first compartment of the next section 8*b* of the header.

partment and the adjoin-

ing second compartment of that section 8*b* has an opening 22 so that liquid can then flow down a limb of the U-tube connected to said second compartment and then through the other limb 2*c* of the U-tube to the second compartment of the first section 8*a*.

This second compartment communicates directly with the third compartment of the first section through an opening 22 in the wall portion between the second and third compartments, and the fluid is therefore led to limb 2*d* of the third U-tube. In a similar manner, the flow continues through successive U-tubes as it is transferred between the compartments of the first and second sections 8*a*, 8*b* until it reaches the last compartment of the first section where an outlet connection (not shown) leads it away to an external circuit.

The illustrated construction has a total of ten header sections, and with the flow arrangement described above it would accommodate five flows in parallel. It will be understood, however, that the number of branches and passes can be differently selected by the arrangement of the inter-connections between successive compartments. These connections need not be confined to the compartments of the same section and it is also possible to transfer fluid from section to section through further openings 22 in the walls between adjoining sections if the bonding between the two sections provides a fluid tight seal in the region of the openings. The header section may be moulded without any openings 22, these being subsequently machined according to requirements for a particular flow path. Using a single form of moulding a large variety of different flow patterns can therefore be accommodated by providing different arrangements of openings, whereby the series of tubes can be connected in part-parallel/part series arrangements of many forms as well as simple parallel or series arrangements.

The connecting sockets for the tube ends each comprise an annular recess 24 between spaced tubular spigots 26,28 fitting inside and outside the tube end respectively. The recess 24 provides a receiver for any adhesive used for assembly, so that known quantities of adhesive can be dispensed to each required location for sealing the tube ends securely to the header sections. Similarly, the cover plate channels 34 can be employed to contain controlled quantities of adhesive.

In the construction described above the header sections are all of identical form except for the provision in them of inlet and outlet connections, which can be provided after the sections are moulded, and successive sections are reversed to allow them to nest closely together.

It is possible for the header sections to have other configurations. For example, although a staggered tube arrangement is shown in Figure 1, it will be understood that similar forms of header according to the invention can be provided for in-line tube arrangements, and if the tube configuration permits it, the compartments of a section can be in line which would allow the section to have a rectangular, flat sided form. It is possible to provide two or more rows of compartments in a single header section, although the greater the number of rows and compartments in each section, the less opportunity there is for making up header structures of very different sizes and configurations from the same components.

For greater adaptability to different flow configurations it is preferred to have a separate compartment in the initial moulding for each tube end connection, but it is possible to provide at least some compartments each with more than one tube connection. It is also possible to form the internal partitioning of a header section as a separate component or components or to form it integrally with the cover plate.

The embodiment illustrated in Figure 2 is of a liquid/gas heat exchanger, more especially a radiator for a water-cooled internal combustion engine. Similarly to the first example, a series of U-tubes 42 are mounted in a matrix 44 composed of conventional support elements and cooling fins. The header in this instance is built up from a series of tubular sections 46 that communicate directly with each other.

Each section 46 comprises two parallel tubular passage portions 48 and opening into the interior of each portion 48 there is a downwardly projecting socket 50 comprising a tubular spigot 52 to be inserted into an end of a U-tube. The successive sections have sealing joints 54 with each other so that when assembled they can form two parallel elongate tubular fluid conduits, which may however be interrupted by one or more internal blanking plates or baffles 56. At the ends of the header the tubular passages are either sealed by similar plates or baffles 56 or have connectors 58 attached to them for external fluid connections. One tubular passage portion of each section has on its upper face a socket 60 which similarly may either be closed from the interior of the tubular or have a connector 58 attached for communication with an external fluid connection. Since the tubes are disposed in a 2-row in-line arrangement in this embodiment, the spigots 52 of a section 46 have their axes in a common plane perpendicular to the tubular passage portion axes.

Liquid directed through one tubular passage portion of a section 46 into one limb of a U-tube will flow by way of the other limb of the tube to the other tubular passage portion of that section on the header. Depending upon whether each tubular portion is open to or sealed off from its coaxial neighbours, the fluid will make a lesser or greater number of passes through the tubes as it flows between inlet and outlet connections, or the inlet connection flow will be branched to flow in parallel through a number of U-tubes, and of course combinations of these two flow patterns are also possible. It will be clear that a great variety of flow configurations are also possible in this example of the invention using a relatively small number of different forms of component.

Further features of the components of this embodiment will be described with reference to Figures 3 to 7, from which it will be seen that each tubular passage portion 48 has at one end a female connec- dially spaced annular

wall portions 66,68 that form a recess 70 between them, with a tapered radially inner face 722. The outer wall portion is axially extended beyond the end of the inner wall portion to form a projection 74 with a similarly shaped annular rim, but with a tapered outer face 76. At its other end each tubular portion has a male connection 78 comprising an axially projecting wall portion 80 and a surrounding recess 82, these being complementary to the recess 70 and projection 74 of the female connection.

The two different forms of connection are oppositely disposed for each tubular passage portion of a header section so that each end face of a section exhibits one female and one male connection 64,78. It is therefore possible to seat together two identical header sections, bringing together their male and female connections and bonding the sections together with adhesive or by ultrasonic welding for example. Because each section end face comprises an annular recess at each connection if adhesive is used the recesses can be employed in the manner already described with reference to the first embodiment, to ensure a measured quantity of adhesive is applied to each joint. In a similar manner, the tube ends are received in recesses 82 between the spigots 52 that fit in the tubes and shorter outer spigots 84, so that a measured quantity of adhesive can be retained for sealing the tube ends in place.

The two tubular passage portions of each header section are connected together by a central web 88 and side projections 90 co-planar with the web form flanges running continuously along both longer sides of the assembled header section to locate the header on the supporting elements of the heat exchanger matrix. The spigots 52,84 depend below these flanges.

The connectors have male and female forms 58*a*, 58*b* respectively (Figure 8) with connection elements corresponding to the male and female connections at the end faces of the header sections, so that they may be secured to the sections in the same manner as adjoining sections are interconnected. The outer ends of these connectors have conventional flexible hose connections 92. The top connections of the sections have similar connection elements, in this case all of the same form to avoid a multiplicity of different parts and a male connection is illustrated. For the purpose of keeping to a minimum a number of different parts to be moulded, the top connections are formed blind with a closure membrane 94 (Figure 7) sealing off the tubular portion interior from the top connection socket 60 and the membrane is drilled or punched out if it is required to use the top connection for an external socket leading to the tubular passage portion.

The blanking plate 56 referred to above may be a separate component to be secured to a header section or it may be moulded integrally with the section, as illustrated in Figure 7, adapted to be punched or drilled out if not required. In a preferred method of manufacturing the header sections the mould tool has movable cores so that it can be arranged to produce a moulding with or without a blanking pl[illegible] be formed with weakenings that facilitates their removal. Figure 7 shows both moulded with a central dimple 96 to locate a drill point for them to be drilled out.

In the header illustrated in Figure 9, the sections are similar to those already described with reference to Figures 2 to 8, but the heat exchanger has widely spaced U-tubes 42 in a staggered arrangement, as a result of which each section has only one socket connection to a tube end. In each section, therefore, a blanking plate 56 seals off one of the sockets 50.

A closely spaced staggered arrangement of tubes is shown in Figure 10. The header sections 46' have stepped joint faces but the annular male/female connections already described in detail with reference to Figures 3 to 7 are provided here also.

In Figures 11 to 13 a further example is illustrated of a header section 102 similar in many respects to those in the examples of Figures 2 to 10. Thus, each section has two parallel tubular passage portions 104 with sockets 106 (in this case two to each passage portion) projecting normal to the plane containing the central axes of these portions for the connection of U-form cooling tubes (not shown), the sockets each providing an annular receiving channel 108 for a tube end. The ends of the tubular passage portions have male and female connections 110, 112 of the form already described with reference to Figures 3 to 7 and they may be similarly formed with blanking membranes in the passage portions as already described.

An external conduit connection 114 projects to one side of the section, its axis perpendicular to the axes of the tubular portions and of the tube sockets. The header section is moulded with a blanking membrane 116 at the junction of the conduit connection and its adjoining tubular passage portion however.

The assembly of a heat exchanger can employ a series of the complete sections illustrated to form the tubular passages, with blanking membranes being removed as required to provide the necessary through flow connections, or only parts may be required of some of the sections of the series. For example, it may be necessary to have only two header sections with external connections, one inlet and one inlet, the remaining sections then being moulded without these connections or having them severed before assembly. If the limbs of the U-tubes are staggered, the end header sections with their external connections may require only a single tubular passage portion and may be moulded thus or have the other passage portion cut off.

The disposition of the external connections in the example of Figures 11 to 13 allows the heat exchanger inlet and outlet connections to be on the same side of the unit without increasing the dimensions in the main plane of the unit (i.e. in a plane parallel to both the axes of the tubular passages and the tube sockets).

It is also possible to adapt the header sections to provide filling and/or draining connections for their heat exchanger. In the preceding illustrated example, if the axes of the tubular passages run vertically [illegible] be inserted in the manner [illegible] end of one of the tubular

passages and be sealed thereto, and Figures 14 and 15 illustrate such an adaptor plug 120 formed with an interrupted top flange 122 for engagement by a conventional car radiator filler cap (not shown).

In the examples of the invention described many of the illustrated jointing faces between members of the headers themselves or between such members and tubing and other conduit members comprise annular or channel-like recesses in which adhesive can be deposited to make a secure sealed joint. It has already been mentioned, however, that the joints may be secured by ultrasonic welding and it is also possible to employ adhesives that can be applied in smaller quantities simply as coatings on the faces to be joined, so it is then not necessary to provide recesses or other reservoir-like formations to retain specific quantities of adhesive at each joint.

CLAIMS

1. A heat exchanger having a plurality of heat exchange tubes and at least one header of plastics material comprising a series of hollow header sections secured together, the header sections having fluid inlet and outlet openings to provide flow conduits for interconnecting said tubes, in at least some of the header sections at least one of said openings being provided with connection means for sealingly engaging a tube end in communication with the hollow interior of the respective header section.

2. A tubed heat exchanger having a plurality of heat exchange tubes and at least one header of plastics material comprising a series of hollow header sections secured together, at least some of said header sections providing at least one tubular passage extending between opposite end faces of the section, the or at least one said tubular passage of said header sections having a tube connection opening provided with connection means for a respective tube end, and an annular sealing arrangement being provided around the respective passage ends in each of the header section end faces for sealing engagement with a further similar hollow header section.

3. A heat exchanger according to claim 2 wherein said header sections each have a pair of parallel passages.

4. A heat exchanger according to claim 2 or claim 3 wherein the or each said tubular passage has complementary forms of annular sealing arrangements surrounding the passage ends at the opposite end faces of the header section to permit series connection of said passages of a plurality of corresponding header sections.

5. A heat exchanger according to claim 3 together with claim 4 wherein the respective adjacent passage ends at each section end face have complementary forms of sealing arrangement.

6. A heat exchanger according to claim 5 wherein the sealing arrangements are in the form of concentric recesses and spigots.

7. A heat exchanger according to claim 4 or claim 5 together with claim 6 wherein one said form of sealing arrange- between inner and outer shoulders for receiving a complementary annular projection of the other sealing arrangement.

8. A heat exchanger according to any one of claims 2 and 7 wherein at least some of the header sections have at least one said passage with a plurality of further openings for fluid flow connections.

9. A heat exchanger according to claim 8 wherein at least one passage is provided with an outwardly projecting tubular extension for a further fluid connection to the passage.

10. A heat exchanger according to claim 9 together with claim 10 wherein a blanking diaphragm formed integrally with the header section acts as a closure for said extension sealing off the interior of the associated passage.

11. A heat exchanger according to any one of claims 2 to 10 wherein at least one header section has a blanking diaphragm formed integrally with the section as a closure member between adjacent regions of a tubular passage.

12. A heater exchanger having a plurality of heat exchange tubes and at least one header of plastics material comprising a plurality of hollow header sections secured together and providing flow conduits for interconnecting the tubes, each header section having openings with connection means for respective tube ends to spaced regions of the interior of the section and partitioning means being provided between the connection means for at least some of the tube ends to divide the interior of the section into a plurality of separate compartments.

13. A header according to claim 12 wherein the header sections are moulded with partitioning means between each adjacent pair of tube end connection means.

14. A heat exchanger according to claim 12 or claim 13 wherein the header sections have adjoining side walls that are bonded together.

15. A heat exchanger according to claim 14 wherein at least some of said side walls have portions removed to provide direct interconnections between adjacent header sections.

16. A heat exchanger according to any one of claims 12 to 15 wherein the header sections have said tube connection openings in their bottom faces and are formed with a separate top cover to permit the selective removal of said partitioning means before the top cover is fixed in place.

17. A tube heat exchanger constructed and arranged for use and operation substantially as described herein with reference to any of the examples illustrated in the accompanying drawings.

18. A header section for a tubed heat exchanger comprising a one-piece plastics moulding having a pair of parallel passages extending between opposite end walls and at least one tube-connecting socket leading transversely from each said passage, the ends of the passages being provided with complementary sealing arrangements for the interconnection of corresponding header sections with their passages in series.

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